

Anatomy and Physiology of the Respiratory System

Anatomy & Physiology of the Respiratory System
(Designed for quick review and deeper study)

1. Overview

- **Primary function:** Exchange of gases (O_2 & CO_2) between the external environment and the bloodstream.
- **Secondary functions:**
 - Regulation of blood pH (via CO_2 elimination)
 - Vocalization (phonation)
 - Protection against inhaled pathogens & particles
 - Olfaction (via the nasal cavity)

2. Gross Anatomy

Region	Main Structures	Key Features
Upper Airway	Nasal cavity, paranasal sinuses, pharynx (nasopharynx, oropharynx, laryngopharynx)	• Warm, humidify, filter air • Ciliated epithelium + mucus trap particles • Rigid cartilaginous support (trachea, main bronchi)
Lower Airway	Larynx, trachea, bronchi, bronchioles	• Smooth muscle-rich bronchioles allow regulation of airflow • Thin (type I) epithelial cells for diffusion
Lung Parenchyma	Alveolar ducts, alveolar sacs, alveoli	• Type II cells secrete surfactant (reduces surface tension)

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Region	Main Structures	Key Features
Pleural Cavities	Visceral pleura (covers lung), parietal pleura (lines thoracic wall), pleural fluid	• Creates a low-friction, sealed environment • Negative intrapleural pressure keeps lungs expanded
Respiratory Muscles	Diaphragm, external intercostals, internal intercostals, accessory muscles (scalene, sternocleidomastoid)	• Diaphragm contraction → intrapleural pressure ↓ inhalation • Expiration is usually passive (elastic recoil)

3. Microscopic Anatomy

Component	Cell Types	Function
Respiratory epithelium (airways)	Ciliated pseudostratified columnar, goblet cells, basal cells	Mucociliary clearance; mucus production
Alveolar epithelium	Type I pneumocytes (flat, for diffusion), Type II pneumocytes (surfactant)	Gas exchange surface; surfactant synthesis
Pulmonary capillaries	Endothelial cells, pericytes	Tight barrier for diffusion; site of O ₂ /CO ₂ exchange
Resident immune cells	Alveolar macrophages, dendritic cells	Phagocytosis of inhaled particles, antigen presentation

4. Mechanics of Breathing

1. Inhalation (Inspiration)

- **Diaphragm** contracts → moves caudally, increasing vertical thoracic volume.
- **External intercostals** contract → ribs elevate, expanding the thoracic cavity laterally.
- **Result:** Intrathoracic pressure falls below atmospheric (≈ -5 cmH₂O); air rushes into lungs.

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2. Exhalation (Expiration)

- **Passive phase:** Diaphragm and intercostals relax ? elastic recoil of lungs and chest wall raises intrathoracic pressure ? air expelled.
- **Active phase (forced):** Internal intercostals and abdominal muscles contract ? further decrease thoracic volume, increasing pressure.

3. Ventilation Parameters